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# The High School Instructor

VOL. 2

SASKATOON, SASKATCHEWAN

No. 8.

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**APRIL, 1936**

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# The High School Instructor

VOL. II

SASKATOON, SASK., APRIL 1936

No. 8

## EDITORIAL

### *Our Magazine Material*

ONLY two more issues of our magazine remain to complete the second Volume, so we feel it the appropriate time to review briefly the work of the two years. In these two Volumes there has been published a wealth of excellent material particularly and permanently valuable to the instructor or the student of the high school courses. In both Volumes there has appeared, when bulked together, a surprising amount of informative and inspirational material in the form of editorials, current events, and historical articles. Volume I gave seven complete courses in Language, Science, and Mathematics. The second Volume has continued the plan of working out complete courses. Another seven courses have appeared on Literature, Language, Science and Mathematics. The editors have not yet settled upon the policy for Volume III. There still remain some courses which can be helpfully treated, but perhaps articles dealing with specific problems over the whole range of the curricula would be more valuable to many teachers. The editors would be glad to receive your suggestions with regard to the content of the magazine, for its purpose is to meet your needs.

### **The Point of View**

The courses have been written with special consideration for the teacher of many grades who must also teach high school work or guide students in their efforts to master the high school subjects with little help. The writers have also kept the handicapped student in mind, and have so written the instalments that the reasonably bright and zealous pupil can do the work month by month from the instructions given and be assured of successful accomplishment when the course is finished. Naturally, no provision can be made for checking the pupils' work; therefore, if possible, there should be some teacher guidance. The magazine, if bound together and kept, forms a valuable asset to the teacher, but if possible the complete issue should be placed in the hands of the handicapped student. The writers will not claim that use cannot profitably

be made of other aids, but they do claim that if the instalments are worked faithfully, there is ample content in the courses treated for a full year's work.

### **The Composition Courses**

In the courses in Written Language, (Grades IX and XI, Vol. I; Grade X, Volume II) the author has endeavoured to unify theory and practice. No rules are given unless they are immediately applied in practice. Each instalment is meant to provide work for one month of the school term. It is not intended that every exercise should be done, but as many should be selected for practice as the time will allow. Have regard for a proper balance between the composition and other subjects and give proper consideration to oral exercises. Much oral work can be done in connection with Literature, and suggestions are made in this regard here and there through those courses.

The course for Grade IX in Volume I is a complete unit, furnishing practice in all the fundamental forms of composition, in punctuation, and in grammar. A student who has followed the course faithfully and whose school career ends with this grade, should have received a grounding in composition which will form a substantial basis upon which to build in whatever career his level of education will permit him to choose.

The course for Grade X in Volume II is meant to give added practice on exercises slightly increased in difficulty, and on some of the more purely mechanical elements of composition. It leads into the course for Grade XI in Volume I.

The latter course is an especially valuable one in as much as it gives a fairly complete formula for the development of a finished literary style. The aim of the course is to develop in the student his creative literary capacities. Creative exercises are required in which the student aims at the use of certain prescribed laws and qualities. These exercises fix in the mind of the pupil by gradual steps a knowledge of the cardinal qualities of style, and give him practice in the attainment of those qualities. By zealous work the student of average mental endow-

ment can acquire a clear, forceful, and interesting style.

### The Courses in Literature

The courses in Literature have avoided undue emphasis on line notes. Nothing can render Literature more distasteful than line by line dissection. The monotonous emphasis on word and line meaning makes any selection humdrum, and destroys any spontaneous interest the pupil may have had. Thereafter his interest is forced, and we can be sure that in future years, unless perchance spontaneous interest is revived by some exceptional circumstance, he will not be interested in Literature for the joy and profit of reading. Our treatment of the courses is of a more general nature. We emphasize the literature of the piece—the thought, the story, character, problems, beauty of imagery, beauty of sound—rather than word meaning and structure. Some attention, of course, should be given to these things but, if the literary qualities are made the vital things, most of the questions regarding structure and word meaning will arise where it should, in the student's own curiosity. He will seek the answers from whatever source is available—dictionary, notes, or teacher—and his spontaneous interest is enhanced rather than destroyed.

The courses are treated sufficiently comprehensively to furnish a full

year's work, but they are not meant to restrict the teacher's individuality. They are meant to suggest rather than to be final plans. The teacher may add or subtract as his individuality and point of view demand.

### The Science Courses

The Science courses for Grades IX and X in Volume I were prepared by a highly successful teacher of Science. Since no text for the requirements in Science in these grades has been previously prepared, the logically developed series of articles given in *The High School Instructor*, when grouped together, will make an excellent text. For these courses alone the teacher should keep the file of the issues intact.

### The Courses in Mathematics

The courses in Mathematics are designed to provide the teacher with a point of view in presenting to his classes the topics treated in the magazine. Methods of presentation which have been tested in the classroom are indicated so that the busy teacher can present to his class in a thorough manner a particular topic in the minimum of time. In introducing a subject the aim has been to present sufficient detail to arouse the interest of the student to the point where he will get a certain amount of enjoyment out of solving the exercises assigned.

*Ready May 12*

## The "Current Events" Annual

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# Grade IX Literature

## AS YOU LIKE IT

### Act III

**Scene I.**—Note the command which Duke Frederick gives Oliver. Already Oliver's wrong-doing is returning upon himself. He was responsible for Orlando's flight to the Forest of Arden, and now the absence of Orlando causes Duke Frederick to vent his wrath on Oliver. It is evident that Duke Frederick has inquired of Oliver concerning Orlando's whereabouts, and that Oliver has told Frederick that he has not seen Orlando since the wrestling. Frederick blames Oliver for Orlando's disappearance and professes to think Oliver has murdered him. All Oliver's possessions are seized by the Duke until such time as he returns with Orlando. It is dramatic justice that the wrong-doer should be punished as a direct result of his wrong-doing, and that he should be deprived of those things he sought to enlarge through wrong.

**Scene II.**—1. The action of the play is again transferred to the forest where it continues to the final curtain. The lovelorn Orlando, unaware that his beloved is in the neighborhood, shows that his love for Rosalind is deep indeed. All his occupation is to write poetry in her honor and to carve her name in the bark of the trees.

*Thrice-crowned Queen of Night.* Diana was the virgin goddess of hunting and the moon. She was also thought of as Hecate, queen of the underworld and the dark and fearful things of night. She is, therefore, spoken of as wearing a triple crown because she ruled in heaven as goddess of the moon, on earth as goddess of the hunt, and in the underworld as wife of Pluto.

2. Note how Touchstone loves to air his wit at the expense of simple shepherd Corin. He likes the solitude, freedom, and simplicity of the forest life, but he professes to find it irksome for lack of company. Corin is a simple soul whose whole philosophy is the knowledge of the commonplace things of everyday. Touchstone teases him because he has never been at court. For each instance of Corin to show that courtly manners would be as much out of place in the country as country manners would be out of place at court, Touchstone returns a witty refutation, until Corin gives up the contest with the statement:

"You have too courtly a wit for me; I'll rest."

He expresses a really fine philosophy of life when he says:

"Sir, I am a true labourer: I earn that I eat, get that I wear; owe no man hate, envy no man's happiness; glad of other men's good, content with my harm: and the greatest of my pride is to see my ewes graze and my lambs suck."

3. Note the brightness of Rosalind's wit. It is no wonder she is anxious to have Touchstone accompany them in exile. He is excellent material for a clash of wits, and Rosalind can match sally for sally. When Touchstone makes fun of the verses Rosalind is reading, and says the tree upon which they were found yields bad fruit, Rosalind replies: "I'll graff it with you, and then I shall graff it with a medlar." The use

of "medlar" suggests "meddler", implying that Touchstone is meddling in what is none of his business. Touchstone is silenced: "You have said; but whether wisely or no, let the forest judge." Rosalind's greeting of Celia, too, when she finishes the reading of the poem, is bright and witty.

Note the subjects for poetry suggested by Orlando in the poem read by Celia: the brevity of life, the unhappiness of human relations, his idealized love. Rosalind, his loved one, is perfection. Heaven has decreed that all graces possessed by world heroines should be concentrated in Rosalind. She should have the beauty of countenance of Helen of Troy, but not her faithlessness, the majestic bearing of Cleopatra; the grace and symmetry of Atalanta; and the modesty of the Roman Lucretia.

*Classical allusions.* (a) Helen of Troy was the beautiful wife of Menelaus, King of Athens. She eloped to Troy with Paris, the son of the Trojan King, Priam. For Paris's breach of hospitality and to recover his bride, Menelaus sought the aid of other Greek princes in a war against Troy.

(b) Cleopatra was Queen of Egypt in the time of Julius Caesar. She was famed for her beauty and majesty of bearing. Caesar is said to have fallen in love with her, and it is certain that Mark Antony, who succeeded Caesar as one of the dictators of the Roman dominions, was blindly in love with her.

(c) Lucretia was a Roman matron in the early days of Rome when the Tarquins ruled. She took her life because she had not been able to defend her honor against Sextus, son of King Tarquin.

(d) There has been a good deal of discussion among critics as to what is "Atalanta's better part," but it must have been those factors which made her swift of foot, as it is this quality which is most emphasized in the story told of her. Having been warned by an oracle against marriage, she refused all suitors but the one who should conquer her in the race, for she thought that no man could. But Melanion achieved it by a trick. He sought the aid of Venus, goddess of love, who gave him three golden apples. Each time he felt Atalanta gaining on him, he dropped one of these. Charmed by the glitter, she delayed to pick them up, and so lost the race.

4. There is no indication that Rosalind had guessed the presence of Orlando in the forest until Celia recalled him to her mind and then graphically describes how she had seen him. Note Rosalind's excitement as it dawns upon her that Celia is referring to Orlando as the writer of the verses. Now she realizes the predicament she is in: "Alas the day! What shall I do with my doublet and hose?"

5. In the short scene between Orlando and Jacques note how Jacques tries to pique (irritate) Orlando, and how Orlando proves a match for him. It is a good exercise in composition to write this scene in indirect speech. Write it as if you were with Rosalind and Celia listening from among the trees.

Jacques has had much experience in life which has caused his serious-mindedness. One can assume that he is on the downward side of middle age. Thus we have the humor of an older man teasing the younger and, as he assumes, less wise in the ways of the world. Jacques' melancholy is more affected than real.

6. Note how Ganymede (Rosalind) contrives to bring the conversation round to Rosalind:

(1) Inquiry as to the time o'clock. (2) Orlando's reply that there is no clock in the forest gives Rosalind a chance to state that there is no true lover in the forest. This statement would touch Orlando directly. (3) Her observations on life cause Orlando to inquire where she lives, and to note that her speech is not in keeping with her life. (4) Rosalind makes up the fiction of a religious uncle, and puts in his mouth condemnation of women. (5) Orlando, deeply in love with one woman, is anxious to know some of their faults. (5) Rosalind will not give the faults of women (her "physic") except to those who need to know them ("those who are sick"). (7) She then refers to one who is sick (in love) knowing that he who carves "Rosalind" on the barks of trees is the one she is addressing.

7. Note Rosalind's description of Orlando and her contrast of his appearance with that of the true lover. Study this carefully and reproduce it orally in your own style and without the aid of the text.

8. What plan do the two agree upon? State this fully by enlarging upon the following details:

- (1) Rosalind tells how she can cure the lovelorn.
- (2) She proposes to cure Orlando.
- (3) He agrees to come every day to her cot and imagine the one whom he believes to be a shepherd, Ganymede, is his very Rosalind. They are to play at wooing.

**Scene III.**—Tell the preliminary part of Touchstone's romance with Audrey, the country wench, using the following outline. Use whatever touches you can to make the story humorous:

- (1) An imaginative picture of Touchstone and Audrey together in the forest with Jacques slyly eavesdropping.
- (2) Touchstone's manner of wooing, and Audrey's seeming contempt for his looks.
- (3) Touchstone's flattery of Audrey.
- (4) Touchstone's plan to be married forthwith by Sir Oliver Martex.
- (5) Jacques enters upon the scene.
- (6) Jacques spoils the hasty marriage to be solemnized by a false vicar.

**Scene IV.**—1. Though she is full of life and gaiety, Rosalind's spirits sometimes sink very low. Why is she now on the point of tears? Note how cleverly Celia draws her from her depression by saying things concerning Orlando's love which are not true and thus causing Rosalind to defend him.

2. Note how deftly the dramatist has arranged to have Rosalind meet the Duke, her father, without her identity being known. Note this fine example of Rosalind's sparkling wit: "He asked me of what parentage I was? I told him of as good as he; so he laughed and let me go."

3. Corin now introduces us to a pleasing scene of pastoral life in which the course of true love does not run smooth. Rosalind welcomes the scene for "the sight of lovers feedeth those in love."

**Scene V.**—1. Why is Silvius so mournful?

2. Describe Phoebe's attitude toward him. Is she really so disdainful as she appears?
3. What is Silvius' wish for Phoebe?
4. How does Rosalind try to help Silvius?

5. As Rosalind speaks, what is the reaction of Phoebe?
6. Does Rosalind, while telling Phoebe she is not pretty, really believe what she says? What details of beauty does she mention?
7. How does Phoebe plan to let Ganymede (Rosalind) know she is in love with "him"?
8. Give Phoebe's description of Ganymede (Rosalind).

### Exercises (Act III)

1. Memorize
  - (a) "Who might be your mother" to "rain."
  - (b) "Think not I love him" to "Silvius."
2. What is the meaning of each of the following words as used in the text: erring, sad, scrip, trow you, coney, quotidian, fancy, point-device, sooth, fantastical, to cry anyone mercy, abused.
3. Explain: (a) thrice-crowned queen of night; (b) Atalanta's better part; (c) His hair is of the very dissembling color, something browner than Judas's; (d) He hath bought a pair of chaste lips of Diana; (e) His kisses are Judas's own children.
4. Express in your own words:
  - (a) "I pray you mar no more of my verses with reading them ill-favouredly."
  - (b) "I will sing my song without a burthen; thou bringest me out of tune."
  - (c) "I will chide no breather in the world but myself; against whom I know most faults."
  - (d) "You are rather point-device in your accoutrements."
  - (e) "None could be so abused in sight as he."
  - (f) "To forswear the full stream of the world and to live in a nook merely monastic."

### Act IV.

**Scene 1.**—1. Jacques is proud of his melancholy, and flatters himself that it is different from that of anyone else. How does he describe the melancholy (serious mindedness—meditation) of other men, and what does he say of his own?

2. When Jacques tries to impress Rosalind with his experience gained as a traveller and with his melancholy, what comment does she make? What is your opinion of the wisdom of her comment?

3. Note that, when Orlando arrives at the trysting place an hour late, Rosalind is at once in the happiest mood—"a holiday humour"—as she says. Describe the scene in such a way as to bring out this spirit and gaiety. Use some dialogue to achieve your purpose. You may use the following outline:

- (1) Rosalind takes Orlando to task for his tardiness.
- (2) "If I were your very very Rosalind." (The mimic love talk).
- (3) No one ever died of love. (The stories of famous lovers of old as interpreted by Rosalind.)
- (4) The mock wedding.
- (5) She makes Orlando promise not to be late again.

**Scene II.**—This brief scene is a very pleasing one when presented on the stage, in fact, one of the most pleasing pictures of the whole play. We have the lords and forest-lovers assembled in merry mood. Their

costumes, the forest surroundings, their merry manner, and the song are entrancing. The song, as set to music by Dr. Arne is a quartet. As the chorus is sung with repeated phrases, one hears the continuous melody of hunting horns of various tone, ranging from high tenor to low bass.

Note Jacques' desire for the song. He professes not to care for the music so much as for the noise. One feels the affectation in Jacques' attitude of disdaining what others enjoy. He is merry enough to enjoy the song, and he certainly delighted in the company of Rosalind and of Touchstone.

**Scene III.**—1. Orlando has already broken his promise not to be late. We learn shortly what has delayed him.

2. Now we have that "taunting" letter which Phoebe promised to write to Ganymede and send by the hand of Silvius. It was unmistakable that Phoebe had become infatuated with Ganymede as "he" scolded her, and he hinted that the letter was a design of Phoebe to let Ganymede know she had fallen in love with her.

(a) Give the contents of the letter in good prose, either oral or written.

(b) Visualize the scene and then describe it imaginatively, emphasizing the attitude of Silvius as he hears what Phoebe has said, and as Rosalind comments on it. This is what the director of a stage production would have to do in order to direct the one playing Silvius as to posture, facial expression, gesture, and so on.

(c) Do similarly with a few other episodes such as (1) Jacques and Orlando; (2) The first appearance of Orlando and Adam in the forest; (3) Silvius telling Corin of his love; (4) Rosalind, Celia, and Orlando after the wrestling; (5) Touchstone, Audrey, and Jacques; (6) Duke Senior and his men at the opening of Act II; and many others.

The appreciation of Shakespeare's work as dramas which were meant for the stage is of primary value. Exercises like those above are splendid aids to such an appreciation.

3. Why had Orlando broken his promise? Who comes to tell of his adventure in the forest? What effect does his message have upon Rosalind?

### Exercises

1. In Act IV the plot of the play begins to unravel. Trace this process of unravelling up to the end of Act IV by showing what has transpired in the following complications:

(1) The romance of Rosalind and Orlando.

(2) Rosalind and her father.

(3) Oliver and Orlando.

(4) Even Touchstone is on the way to wedded happiness (?).

2. For what reasons are the various characters who seek refuge in Arden led to do so? Show how they find happiness in the forest. Are any of those who dwell there untouched by its peace and beauty?

3. Learn by heart "When last the Young Orlando parted from you."

4. Give the meaning of (a) a melancholy compounded of many simples; (b) more new fangled than an ape; (c) were man as rare as phoenix; (d) the boy is of female favour.



# Grade IX Arithmetic

## Present Value

If a man owes me \$100 one year from today, how much should I accept in payment of the debt if he pays me today? Obviously, I should not expect him to pay me \$100 for that is the sum he must pay me a year from today. He will, therefore, pay me less than \$100. As a matter of fact, he will pay me that sum of money which, if put at interest at a current rate for one year, will amount to \$100. Thus, if the current rate of interest is 6%, then 106% of the sum he must pay me is \$100. Therefore, the sum he must pay me is  $100/106 \times 100 = 100/1.06 = 100 \times 1/1.06 = 100 \times .9434 = \$94.34$ .

The sum he must pay me, therefore, is \$94.34. We can verify this by finding the interest on \$94.34 at 6% for 1 year. Thus, the interest is  $\$94.34 \times 6/100 = \$5.66$ . Therefore, the amount of \$94.34 in 1 year at 6% is  $\$94.34 + \$5.66 = \$100$ . We say that \$94.34 is the *present value* or *present worth* of \$100 due a year from now.

Note that the present value of \$100 due in a year was obtained by dividing \$100 by 1.06 or by *multiplying* \$100 by  $1/1.06$ .

Now let us see what  $1/1.06$  represents. If the man owed me \$1 instead of \$100 in a year, then the present value of \$1 would be  $100/106 \times 1 = 1/1.06 = .9434$  or a little more than 94 cents. Thus we see that  $1/1.06$  is the present value of \$1 due at the end of one year when money is worth 6%. Therefore, the present value of \$260 for the same time and rate is  $\$260 \times 1/1.06$ . Similarly, the present value of \$25.34 is  $\$25.34 \times 1/1.06$ . Note also that  $1/1.06$ , the present value of \$1, is equal to 1 divided by the *amount* of \$1 for the time and rate. Since the amount of \$1 for 2 years at 6% compounded is  $(1.06)^2$ , therefore, the present value of \$1 at the end of two years at 6% is  $1/(1.06)^2$ . Hence the present value of \$324.65 due in two years at 6% is  $\$324.65 \times 1/(1.06)^2$ . Similarly, the present value of \$400 due in 5 years at 6%, compounded yearly, is  $\$400 \times 1/(1.06)^5$ . Similarly also, the present value of \$200 due in 6 years at 5%, compounded half-yearly is  $\$200 \times 1/(1.025)^{12}$ .

*Example 1.* What is the present value of \$300 due in  $7\frac{1}{2}$  years at 5% compounded yearly?

The amount of \$1 for  $7\frac{1}{2}$  years at 5% is  $(1.05)^{15} \times 1.025$ . Therefore, the present value of \$300 due in  $7\frac{1}{2}$  years at 5% is  $\$300 \times 1/(1.05)^{15} \times 1.025 = 300/1.44 = \$208.33$ .

The tables on pages 286 and 287 give the present values of \$1 at various rates due in 1 to 40 years.

*Example 2.* Find the present value of \$23.31 due in 10 years, money being worth 5% per annum, compounded half-yearly?

Present value =  $\$23.31 \times 1/(1.025)^{20} = \$23.31 \times .61027 = \$14.23$ .

*Example 3.* I rent my house for \$500 a year payable at the end of the year. How much would I receive now if I were paid the next 5 years rent in advance, money being worth 6% per annum, compounded yearly?

To find how much I would receive I must find the sum of the present values of \$500 due at the end of the 1st year, \$500 due at the end of the 2nd year, \$500 at the end of the 3rd, \$500 at the end of the 4th, and \$500 at the end of the 5th. Hence the sum I should receive now is,

$$\begin{aligned}
 & \$500 \times 1/1.06 + \$500 \times 1/1.06^2 + \$500 \times 1/1.06^3 + \$500 \times 1/1.06^4 \\
 & + \$500 \times 1/1.06^5 = \$500 (1/1.06 + 1/1.06^2 + 1/1.06^3 + 1/1.06^4 \\
 & + 1/1.06^5) = \$500 (.94340 + .89000 + .83962 + .79209 + .74726) \\
 & = \$500 \times 4.21237 = \$2106.19.
 \end{aligned}$$

### Mortgages

A mortgage is a document in which one person agrees to transfer to another his title to a piece of property in the event that he is not able to make payment of a certain sum of money due at a certain time, or meet the interest payments on the debt due at the end of each year for the term of years for which the mortgage was made.

If I borrow \$5000 from A the latter will no doubt require me to give him a mortgage on my house. The mortgage will set out that I am to pay A interest at the end of each year on the \$5000 at the rate of 7% per annum, and to return the \$5000 at the end of 5 years. The interest due at the end of each year is \$350. Suppose the mortgage is executed, that is, signed by the parties to it, on March 1, 1936. The principal or the sum of \$5000 is due on March 1, 1941. Any time between March 1, 1936, and March 1, 1941, A may sell or assign the mortgage that he holds on my house. Suppose that I make my payments of \$350 due on March 1, 1937, and March 1, 1938, and that immediately after I make my March 1, 1938, payment, A assigns the mortgage to B. How much should B pay for the mortgage? In other words, what is the present value of the mortgage on March 1, 1938? Under the terms of the mortgage there are three years yet to run, and there is due at the end of each of the three years the sum of \$350, together with the sum of \$5000 due at the end of the third year. Assuming that money is worth 6% per annum, B should pay for the mortgage  $\$350 \times 1/1.06 + \$350 \times 1/1.06^2 + \$350 \times 1/1.06^3 + \$5000 \times 1/1.06^3 = \$350 (1/1.06 + 1/1.06^2 + 1/1.06^3) + \$5000 \times 1/1.06^3 = \$350 \times 2.67302 + \$5000 \times .83962 = \$935.56 + \$4198.10 = \$5133.66$ .

Suppose this mortgage was sold by A on June 7, 1938, how much should B pay for it?

The present value of the mortgage on March 1, 1939, is

$$\begin{aligned}
 & \$350 \times (1/1.06 + 1/1.06^2) + \$5000 \times 1/1.06^2 \\
 & = \$350 \times 1.8334 + \$5000 \times .89 \\
 & = \$641.69 + \$4450 = \$5091.69.
 \end{aligned}$$

Now the number of days from June 7, 1938, to March 1, 1939, is 267.

The amount of \$1 for 267 days at 6% is  $1 + (1 \times 6/100 \times 267/365) = 1 + .0438 = 1.0438$ .

$\therefore$  Present Value of mortgage on June 7, 1938

$$= \$5091.69 \times 1/1.0438 = \$4878.03.$$

Some mortgages require the interest to be paid half-yearly or twice a year. If this were required in the above mortgage the sum of \$175 would be paid every half-year for 10 half-years.

Suppose the interest is paid half-yearly and money is worth 6% compounded yearly, what would be the present value of the above immediately after the interest payment has been made on March 1, 1938?

There are 6 payments of \$175, the first being due in 6 months, the second in 1 year, the third in one and one-half years, etc.; therefore, the present value of the mortgage is  $\$175 \times 1/1.03 + \$175 \times 1/1.06 + \$175 \times 1/(1.06 \times 1.03) + \$175 \times 1/1.06^2 + \$175 \times 1/(1.06^2 \times 1.03) + \$175 \times 1/1.06^3 + \$5000 \times 1/1.06^3$ .

You would have to work out the present value of each payment

separately and add the results to get the present value of the mortgage.

If interest is paid half-yearly and money is compounded half-yearly, then the present value of the above mortgage on March 1, 1938, is  $\$175 \times 1/1.03 + \$175 \times 1/1.03^2 + \$175 \times 1/1.03^3 + \$175 \times 1/1.03^4 + \$175 \times 1/1.03^5 + \$175 \times 1/1.03^6 + \$5000 \times 1/1.03^6$ .

If the interest is paid yearly and money is compounded half-yearly, the present value of the above mortgage on March 1, 1938 is  $\$350/1.03^2 + \$350/1.03^4 + \$350/1.03^6 + \$5000/1.03^6$ .

Do questions 1-25, pages 191-193 text.

### Partnership

When two or more persons join together to carry on a business, the association thus formed is called a partnership.

How is the net profit of the business divided? The net profit is the amount left of the annual receipts after all expenses have been taken care of, including depreciation. The net profit is usually divided among the partners in proportion to their respective capital investments in the business.

For example, if A, B, and C, form a partnership, and A contributes  $1/3$  of the total capital invested in the business, B,  $1/2$ , and C,  $1/6$ , then A should receive  $1/3$  of the net profit, B,  $1/2$ , and C,  $1/6$ . In other words, each partner should receive that fraction of the net profit that he supplied of the total capital.

Now do questions 1-5, page 194.

## GRADE IX LITERATURE

*Continued from page 7*

5. What is the outstanding literary quality of each of the following passages?
  - (a) "Under an oak, whose boughs were massed with age,  
And high top bald with dry antiquity."
  - (b) "A green and gilded snake."
  - (c) "I will be more jealous of thee than a Barbary cock-pigeon over his hen."
  - (d) "Od's my will!  
Her love is not the hare that I do hunt."
  - (e) "West of this place, down in the neighbour bottom,  
The rank of osiers, by the murmuring stream,  
Left on your right hand, brings you to the place."

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# Grade X Literature

## JULIUS CAESAR, Act V

### Scene I.

You will recall that, at the conference of generals in Sardis, Brutus urged an immediate march to Philippi to meet the approaching forces of Antony and Octavius. He urged, as an argument in favor of this policy, that the forces of Antony and Octavius could not then increase in numbers by enlistments from the extensive territories between Philippi and Sardis. Cassius opposed the move on what seemed to be sound military considerations. He argued that if they remained at Sardis, their troops would be fresh, while those of the enemy would be worn out and drawn away from their base of operations which was in Rome.

A number of circumstances indicate that fate is against the success of Brutus and Cassius:

1. Brutus's argument that Antony and Octavius would increase their numbers in the territory between Philippi and Sardis indicates that there is not loyal support in the very territory from which they had raised their armies, and which they considered their strongholds.
2. The quarrel between Cassius and Brutus indicates that there is not the necessary unity in the leadership of the armies to ensure success.
3. Brutus's attitude of mind at the time of the appearance of Caesar's ghost indicates that Brutus is dispirited. This is not a frame of mind on the part of a leader which foretells success.
4. The news of the proscription, and of the death of Portia, is ominous, suggesting that the triumvirs have the upper hand.

Now the opposing troops meet on the battlefield at Philippi, on a plain between the hills and the sea. Octavius, though only nineteen, indicates the generalship and military insight which made him the first emperor of Rome, Augustus I. Octavius has sensed the impractical generalship of Brutus which has placed the troops of the latter at a disadvantage, but Antony is wrong in his judgment of the courage of Brutus and Cassius. Whatever may have been their weakness, they do not prove themselves lacking in courage.

1. Note the imperial blood of Octavius, the adopted son and heir of Caesar. His words in reply to Antony's assumption of command foretell that independence of spirit which ultimately opposed the ambitions of Antony and brought this young man to rule Rome as her emperor. He has the blood of a king in his veins, and cannot be commanded for long by the man who was "a masquer and a reveller" and who later sold half the world for the doubtful love of Cleopatra.

2. The battle opens with a parley. This would seem to be purposeless in view of the completeness of the estrangement between the opposing leaders. It is a war of words, a touch by which the dramatist prepares us for the final defeat of Brutus and Cassius. Note the bitterness of Antony's words, the sarcasm of Cassius, the continued idealism of Brutus,

and the impatience of Octavius. Cassius now has the opportunity to say to Brutus in effect, "I told you so."

3. The confidence of Antony and Octavius presage victory for them and defeat for Brutus and Cassius.

4. Note the forebodings of Cassius. He says farewell to his general, Messala, protesting that he had been led into unwise military tactics. Historically it is not true that only one battle was fought. Two battles were fought at intervals of twenty days. In the first Brutus gained the advantage over Octavius, but in the later battle the combined forces of Brutus and Cassius were routed. Shakespeare is more concerned with exhibiting the spirits of men which dominated history than with the facts of history.

*The Epicurean Philosophy.* Cassius was an Epicurean, a beautiful philosophy in many respects, but not sufficient to sustain Cassius in his hour of need. Epicurus taught as a primary principle that happiness was the aim of life. To achieve the greatest happiness the following were some of the necessary attributes to life:

(1) *Temperance.* Man must be temperate in all things for intemperance destroys mental and physical well-being and so leads to unhappiness.

(2) *Justice.* Injustice causes unhappiness to others. Man is social by nature, therefore the ultimate of happiness cannot be achieved by any individual if his fellows are unhappy.

(3) The fullest development of the mind and body. Man has achieved only the highest in happiness when he has made the most of himself mentally and physically.

(4) The Epicurean held that the greatest cause of unhappiness was fear, and that the worst of our fears are superstitious fears. Therefore, he taught a disbelief in the control of the gods over the lives of men. He did not deny the existence of the gods, but he held that they lived in a world apart, and were concerned neither in man's sorrows nor his pleasures. This doctrine led to a disbelief in life after death. This life was all that mattered. Man's sole pursuit was a happy existence here. Herein lay the chief weakness of the philosophy, for it led to easy suicide. If the circumstances of life became so difficult as to make comfortable life impossible there was little incentive in the philosophy to urge one on to live down unpleasant circumstances. He simply took death as the way out of difficulties.

Cassius' Epicureanism wavers when he begins to put credence in circumstances which were looked upon with superstitious awe.

5. Both Brutus and Cassius have a premonition of defeat and discuss what they will do in that event. Note the contrast between the philosophy of Brutus and that of Cassius. Brutus was a Stoic, a philosophy founded by Zeno, and contemporary with Epicureanism. The two philosophies had much in common, but Stoicism differed in two essentials. First, the Stoic retained a belief in the interest of the gods in the destiny of man, in the rewards and punishments of the gods. Secondly, the Stoic believed that man should endure his troubles uncomplainingly. He should not inflict his unhappiness on those about him. These two principles, belief in the gods and endurance, forbade self-destruction. Yet Brutus did not find this philosophy sufficient to sustain him. When Cassius suggests that he may be dragged in dishonour through the streets of Rome he intimates that he would not permit himself to be taken alive.



The farewell between Brutus and Cassius is touching indeed. It proved, as Brutus expressed it, an "everlasting farewell."

### Scene II.

1. Brutus begins the battle.

### Scene III.

1. Trace through this scene the fatal mistake made by Cassius whose fears and premonitions led him to accept too readily Pindarus' report of the battle. Tell the story of Cassius' death by filling in the details of the following outline:

- (1) Titinius makes an unfavorable report of the battle.
  - (2) Pindarus' alarm for the safety of Cassius.
  - (3) Titinius sent on a mission.
  - (4) Pindarus' report.
  - (5) Cassius' request. Why did Cassius feel he could claim this service from his servant, Pindarus.
  - (6) The death of Cassius.
2. The death of Cassius discovered; a tribute to the worth of Cassius.
- (1) Messala and Titinius arrive to report a partial victory.
  - (2) Cassius' body is found. Note the beautiful tribute paid to Cassius by Titinius. Whatever his faults, Cassius was noble. This tribute of Titinius is not the only evidence, for had he not been a life-long friend of the noble Brutus. Memorize the lines:  
"O setting sun".....to....."deed."
  - (3) Titinius places the wreath on the brow of the dead Cassius.
  - (4) Titinius follows his friend in death.
  - (5) Note the sorrow of Brutus over the death of Cassius, but how stoically he controls it!

### Scene IV.

Brutus is now fighting desperately a hopeless battle. Note how Lucilius adopts the identity of Brutus in order to prevent the capture of his leader. Antony is now completely victorious.

### Scene V.

1. Tell the story of the death of Brutus. What is the significance of the fact that none of his close friends expect Strato would aid in his death.

2. Memorize the tribute paid to Brutus by Antony. This is a beautiful and truthful summary of Brutus's character. Here the curtain should fall, for the last words of Octavius serve merely to detract from the effect. The words mark the end of Brutus, and the tragedy of his life made the play, so let the curtain fall.

### Review of Act V.

1. Shakespeare wishes to leave clearly with the audience the fact that it was the influence of Caesar in the world of men which Brutus was opposing, that spirit which finally triumphed when young Octavius became the autocratic ruler of Rome as the imperial Augustus. The name of Caesar or Caesar's spirit is mentioned in the play more than eighty times subsequent to the assassination. Note that in Act V he emphasizes that Antony and Octavius are but instruments of Caesar's spirit.

1. Cassius' dying words are:  
"Caesar, thou art revenged,  
Even with the sword that killed thee."
2. Brutus says upon seeing the bodies of Cassius and Titinius:  
"O Julius Caesar, thou art mighty yet!  
Thy spirit walks abroad, and turns our swords  
Into our own proper entrails."
3. Brutus relates the several appearances of Caesar's ghost.
4. Antony says:  
"All the conspirators save only he  
Did that they did in envy of *great Caesar*."

II. Dramatic justice causes Brutus to be punished for his errors. Misjudgments had led him to plot and to be instrumental in the death of Caesar. He had said at the time that he had the same dagger for himself when it should please his country to need his death. Dramatic justice requires his death. Such is the art of the dramatist. But Shakespeare has built up a noble character whose mistakes were made because of ideals. He maintains this high opinion in the minds of the audience to the very last—till the final curtain and after, as the audience carry away the memory of this noble man. In this final act we have these tributes to Brutus.

1. He dies for his cause.
2. He thinks well of Caesar, regretting with his dying breath that he had killed him:  
"Caesar now be still,  
I killed not thee with half so good a will."
3. Brutus can say of himself:  
"My heart doth joy, that yet in all my life  
I found no man but he was true to me."
4. None of his friends would be the means of his death—a tribute of love.
5. He faces death calmly.
6. Antony pays him immortal praise.

### Review of the Play

As a preliminary to a careful analysis of the characters of the play, and more searching consideration of problems contained in the action, we should make a good summary of the story. It will be well to write it from the following outline.

1. The Triumphal Day.
  - (a) The opposition to Caesar.
  - (b) The attitude of the crowd.
2. Cassius conceives a plot.
3. He enlists supporters.
4. How he sets out to win Brutus and why.
5. Warnings and unnatural happenings.
6. The assassination.
7. Events following the assassination.
  - (a) Turmoil.
  - (b) Antony in the presence of the conspirators mourns over Caesar.

- (c) The addresses in the Forum—Antony stirs the mob.
- (d) The flight of Brutus.
- 8. Plans of the Triumvirs.
- 9. Brutus and Cassius at Sardis.
- 10. The Battle of Philippi.
- 11. The death of Cassius and of Brutus.

**Note.**—In the next two issues, under the heading *On Thinking It Over*, we shall discuss characters and general problems of the play. We shall try to do what intelligent persons would do who had witnessed the play on the stage and were discussing it afterwards.

## Science Tests

### Grade IX

1. Summarize the life history of the common housefly by completing the following table. (Use as much space as you need.)

Stage in Life History	Time Spent in Stage	Material in which Stage is Lived	Diagram of Stage
1.....	.....	.....	.....
2.....	.....	.....	.....
3.....	.....	.....	.....
4.....	.....	.....	.....

2. Write an account of the various methods which may be used to control the grasshopper.

3. Write a short essay on the topic "Life History and Control of the Mosquito."

### Grade X

1. Write an account of methods you would use to control the cut-worm.

2. Describe the mouth parts of two different kinds of insects and with reference to differences occurring, show methods needed to destroy each.

3. Write an essay on the topic "Birds, Our Feathered Friends", using the following topics:

- (a) Names and Classification of Birds.
- (b) Economic Importance of Insectivorous Birds.
- (c) Economic Importance of Carnivorous Birds.
- (d) Birds which Merit Destruction and Why.
- (e) Means of Encouraging Birds to Nest about our Homes.

# Grade X Written Language

## Some Forms of Exposition

In our discussion of exposition in the course in Grade IX Written Language we dealt with the four fundamental forms of exposition and presented simple models and exercises. Those forms are: (1) definition (explanation of terms); (2) explanation of processes; (3) explanation of natural phenomena; (4) propositions. Under these headings a great many forms of exposition may be considered, such as book reviews, biography, tastes, and principles. We shall consider now a few models of exposition somewhat more difficult than those of Grade IX.

### Model 1.—A Definition of Argument

"Argument is one of the most common as well as one of the most important forms of composition. If you disagree with your classmates about the merits of a team or about the method of doing an example, an argument probably ensues. If you pick up a newspaper or look at a bulletin board, you see an argument for buying this or that. An advertisement is an argument in favor of the merits of something that is for sale. When salesmen or saleswomen try to persuade you to buy a certain article, they make use of argument. Lawyers in the courtroom argue cases before judge and jury to see which of the two litigants is in the right. In Congress, legislators argue the merits and demerits of proposed reforms before laws are made. So you see that argument may be a very simple form of composition, or a very complex one—simple, when a boy tries to show his mother that he should be allowed to go to the circus; complex, when ambassadors from many countries gather around a table to settle disputes among nations."—*Canby and Opdycke: The Mechanics of Composition*.

*Analysis.*

1. This is a simple definition of a term. It answers the question, *What is argument?*
2. Note the general, strong statement by which the topic is introduced.
3. The term is made clear by a number of illustrations leading from simple, everyday experience to more complex, less common ones—disagreement on merits of a team, advertisements, sales talks, legal pleas, parliamentary talks.
4. Note the conclusion and the effectiveness of the illustrations in the last sentence.

### Exercises

Define by use of illustration, as in the model, two of the following. They should be one paragraph treatments.

- (1) A newspaper; (2) a gossip; (3) a snob; (4) a department store; (5) sportsmanship; (6) feudalism; (7) charity; (8) love; (9) an optimist; (10) a good teacher.

### Model 2.—What is Poetry

"Poetry is that fine particle within us that expands, rarefies, refines, raises our whole being; without it 'man's life is as poor as a beast's'.

Man is a poetical animal; and those of us who do not study principles of poetry act upon them all our lives, like Moliere's 'Bourgeois Gentil-homme', who has always spoken prose without knowing it. The child is a poet, in fact, when he plays at hide-and-seek, or repeats the story of Jack the Giant-killer; the shepherd boy is a poet when he first crowns his mistress with a garland of flowers; the countryman when he stops to look at a rainbow; the city apprentice when he gazes after the Lord Mayor's Show; the miser when he hugs his gold; the courtier who builds his hopes upon a smile; the savage who paints his idol with blood; the slave who worships a tyrant or the tyrant who fancies himself a god—the vain, the ambitious, the proud, the choleric man, the hero and the coward, the beggar, the king, all who live in a world of their own making; and the poet does no more than describe what all the others think and act."—*Hazlitt*.

*Analysis.*

1. The model defines poetry but it does so by stating a *proposition* and proceeding to prove the proposition.

2. The proposition is contained in the first sentence. "Poetry is that fine particle within us that expands, rarefies, refines, raises our whole being." That is, there is a quality in the heart of every man—emotion, fancy, aspiration—which is essentially poetical.

3. The proposition is proved by giving illustrations—the child at make-believe, the shepherd boy in love, the countryman contemplating the beauty of nature, the city boy's delight at pageant, the miser's consuming passion for gold, the courtier's hopes, the religious frenzy of the savage, and so on.

Note the repetition of his illustrations by means of names for various classes of men representing a cross-section of society.

4. Note the conclusion. The poet is one who is able to express the poetry which is elemental in us all.

### Exercises

In a similar manner write an exposition of two of the following. Seek carefully in your thought for illustrations of the truth of your proposition. Jot them down, put them in ascending order of importance, and then write.

1. What is a good education?
2. What are the values of talking pictures?
3. What are the possible evils of talking pictures?
4. What are the benefits of receiving one's elementary education in a rural school?
5. What are the disadvantages of receiving one's elementary education in a rural school?

### Model 3.—How to Obtain Lasting Peace

"The proposition is peace. Not peace through the medium of war; not peace to be hunted through the labyrinth of intricate and endless negotiations; not peace to arise out of universal discord, fomented from principle, in all parts of the empire; not peace to depend on the juridical determination of perplexing questions, or the precise marking the shadowy boundaries of a complex government. It is simple peace; sought in its natural course, and in its ordinary haunts. It is peace sought in the spirit of peace; and laid in principles purely pacific. I propose by removing the ground of the difference, and by restoring the former



unsuspecting confidence of the colonies in the mother country, to give permanent satisfaction to your people; and (far from a scheme of ruling by discard) to reconcile them to each other in the same act, and by the bond of the very same interest which reconciles them to British government."—*Edmund Burke*.

### *Analysis.*

1. The method of explaining in this model is to eradicate first all opinions contrary to his proposals—peace enforced through war, peace through bargaining, peace arising out of differences, peace depending on the judgment of jurists called to settle perplexing questions.

2. He then states his proposition for peace—peace sought in the spirit of peace, peace obtained by removing the grounds of difference, peace arising from confidence. The result, so far as the colonies are concerned, will be reconciliation with one another and with the mother land.

### **Exercises**

Explain, by a similar method, two of the following. First determine what is the principle you advocate, then eradicate principles you consider false or ineffective, and then state and clarify your own point of view.

1. The True Meaning of Friendship.
2. The proposition is the abolition of poverty. (Use this as the opening sentence).
3. How Crime May be Abolished. (Use an opening similar to that in the model).
4. The Value of Reading.
5. The Value of Day-Dreams. (The Value of Looking Ahead).
6. The Value of Retrospect. (Looking Backward).
7. The Value of an Absorbing Hobby.

### **Model 4.—Love of Travel**

"I was always fond of visiting new scenes, and observing strange characters and manners. Even when a mere child I began my travels, and made tours of discovery into foreign parts and unknown regions of my native city, to the frequent alarm of my parents, and the emolument of the town-crier. As I grew into boyhood, I extended the range of my observations. My holiday afternoons were spent in rambles about the surrounding country. I made myself familiar with all its places famous in history or fable. I knew every spot where a murder or robbery had been committed, or a ghost seen. I visited the neighboring villages, and added greatly to my stock of knowledge, by noting their habits and customs, and conversing with their sages and great men. I even journeyed one long summer's day to the summit of the most distant hill, whence I stretched my eye over many a mile of terra incognita, and was astonished to find how vast a globe I inhabited.

"This rambling propensity strengthened with my years. Books of voyages and travels became my passion, and in devouring their contents I neglected the regular exercises of the school. How wistfully would I wander about the pier-heads in fine weather, and watch the parting ships, bound to distant climes; and with what longing eyes would I gaze after their lessening sails, and waft myself in imagination to the ends of the earth!

"Further reading and thinking, though they brought this vague inclination into more reasonable bounds, only served to make it more decided. I visited various parts of my own country; and had I been merely a lover of fine scenery, I should have felt little desire to seek elsewhere its gratification, for on no country have the charms of nature been more prodigally lavished. Her mighty lakes, like oceans of liquid silver; her mountains with their bright aerial tints; her valleys teeming with wild fertility; her tremendous cataracts, thundering in their solitudes; her boundless plains, waving with spontaneous verdure; her broad, deep rivers, rolling in solemn silence to the ocean; her trackless forests, where vegetation puts forth all its magnificence; her skies, kindling with the magic of summer clouds and glorious sunshine;—no, never need an American look beyond his own country for the sublime and beautiful of natural scenery.

"But Europe held forth all the charms of storied and poetical association. There were to be seen the masterpieces of art, the refinements of highly cultivated society, the quaint peculiarities of ancient and local custom. My native country was full of youthful promise; Europe was rich in the accumulated treasures of age. Her ruins told the history of the times gone by, and every mouldering stone was a chronicle. I longed to wander over the scenes of renowned achievement—to tread, as it were, in the footsteps of antiquity—to loiter about the ruined castle—to meditate on the falling tower—to escape in short from the commonplace realities of the present, and lose myself among the shadowy grandeurs of the past."—*Donnelly: Model English*.

### *Analysis.*

1. Note (1) that this model is a short, complete essay; (2) that it is somewhat narrative in character; (3) that parts of it, particularly the third paragraph are descriptive in character.

2. The composition is an exposition (setting forth) of the author's love of travel. He accomplishes his purposes by giving in some respects a sketch of his life. At least he sketches his life in so far as his love of travel is concerned.

3. The paragraph topics are as follows:

(1) His travels in childhood and boyhood—details of ever widening excursions.

(2) The desire to travel increased by reading and by watching departing ships.

(3) The desire not satisfied by the beauties of his native country. Note how the paragraph presenting the beauties of American scenery is developed by enumerating details. Note also the use of figures of speech—"like oceans of liquid silver", "thundering",—and the concrete and descriptive language.

(4) His longing to see the cultural objects of Europe. Note how this paragraph is developed by contrasting youthful America with old Europe.

### **Exercises**

Write an essay of similar length (450 words) and the same number of paragraphs on one of the following topics. A suggested outline is given for the first three:

1. A Love of Reading. (From the point of view of an adult).

- (1) Childhood tastes—early childhood, boyhood or girlhood days.
  - (2) The desire to read increases with the years through reading fiction, books of travel, biography, etc.
  - (3) The desire is not satisfied by the library of the town, with its wealth of books.
  - (4) But a longing to possess a library of his own takes hold of the author.
2. A description of the growth of any great man's prevailing ambition; e.g., Edison, Pasteur, Florence Nightingale, Robert L. Stevenson, Champlain, etc.
- (1) How the person became first interested in the pursuit.
  - (2) How the ambition grew with the years.
  - (3) How attractive fields in other directions were not satisfying.
  - (4) How he eventually achieved his ambition.
3. A sketch of the life of one of the writers whose work you have read in part; e.g., Tennyson, Scott, Coleridge, Shakespeare, Arnold, etc.
- (1) His childhood and education—surroundings, schools, influences.
  - (2) His early work.
  - (3) The development of his work.
  - (4) The qualities of his work, or his place in the world of literary figures.
4. The Life Story of a Great Athlete.
  5. The Love of Trees.
  6. The Joys of Bird Study.
  7. The Life Story of A Great Discoverer.

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# Grade XI Algebra

## INDICES

What is an index? An index is the number written to the upper right of a quantity to indicate the number of times the quantity is to be multiplied by itself. Thus  $a^3$  means  $a \times a \times a$ , that is " $a$ " multiplied by itself three times. The whole quantity  $a^3$  is called the *power*, the 3 is called the *index*, and the " $a$ " is called the *base*. If a quantity is enclosed in a bracket and the bracket raised to an index, it means that the quantity in the bracket is to be multiplied by itself the number of times indicated by the index. Thus  $(ab)^4 = ab \times ab \times ab \times ab = a^4b^4$ .

As a preparation for the study of the laws of indices do the questions on page 293 of the text.

*Note.*—In order to print letter indices in their proper place at the upper right of a quantity, special characters are required. As these are not available at this time it has been necessary in this article to print the letter index on the same line as the base. In each case, however, the letter index is in small type, so there should be no confusion in reading; thus,  $a_m$  is  $a$  to the  $m$ th,  $A_{m+n}$  is  $A$  to the  $(m+n)$ th.

## The Law of Multiplication

We already know that  $a^2 \times a^3 = a^5$ . We see that this is so because  $a^2 = a \times a$  and  $a^3 = a \times a \times a$ ; therefore,  $a^2 \times a^3 = a \times a \times a \times a \times a$ ; and " $a$ " multiplied by itself five times is  $a^5$ . From this we see that 5, the index of the product, is equal to the sum of 2 and 3, the indices of  $a^2$  and  $a^3$ . Is it true, therefore, that to multiply two quantities with the same base we add their indices? The answer is "yes" and the proof of the answer is as follows: Let  $a_m$  and  $a_n$  be two quantities where " $m$ " and " $n$ " stand for positive integral numbers. By an integral number we mean one that is whole, not fractional. We must prove, therefore, that  $a_m \times a_n = a_{m+n}$ .

Now, since  $a^5$  means " $a$ " multiplied by itself 5 times, then  $a_m$  means " $a$ " multiplied by itself  $m$  times, and  $a_n$  means " $a$ " multiplied by itself  $n$  times.

Hence  $a_m \times a_n = (a \times a \times a \dots m \text{ times}) (a \times a \times a \dots n \text{ times})$ . Here we have in the first bracket  $m$   $a$ 's multiplied together and in the second  $n$   $a$ 's multiplied together. We have, therefore, in the two brackets " $a$ " multiplied together  $m+n$  times.

$$\therefore a_m \times a_n = a \times a \times a \dots m+n \text{ times.}$$

Now " $a$ " multiplied by itself 5 times is  $a^5$  and " $a$ " multiplied by itself 11 times is  $a^{11}$ , therefore, " $a$ " multiplied by itself  $m+n$  times is  $a_{m+n}$ .

$$\therefore a_m \times a_n = a_{m+n}.$$

We thus have proved that when two quantities having the same base are raised respectively to indices which are positive and integral, the index of the product is obtained by adding the indices of the quantities. This law is known as the *law of multiplication*. We must note particularly that the quantities must have the same base. Thus, the law does not apply to  $a_m \times b_n$ .

Note, too, that the law holds good when the base is a number instead of a letter. Thus:

$$2^3 \times 2^4 = 2^{3+4} = 2^7.$$

Students who seem to know the laws of indices thoroughly when the base happens to be a letter, get badly confused when the base is a number. They will make such *incorrect* statements as  $2^3 \times 2^4 = 4^7$ ; or  $2^3 \times 3^4 = 6^7$ . The reason for this is that they are attempting to apply the law of the multiplication table which says  $6 \times 7 = 42$ . Hence they feel that in  $2^3 \times 3^4$  they should multiply the bases 2 and 3 to give 6, and add the indices 3 and 4 to give 7. Now this is obviously wrong. The only time we can multiply the bases together is *when the indices are the same*. Thus  $3^2 \times 4^2 = 12^2$  and  $a^3 \times b^3 = (ab)^3$ . The reason why  $6 \times 7 = 42$  is that 6 and 7 are both raised to the index 1 understood. Hence, when the bases are multiplied together the result is raised to the common index.

### The Law of Division

Here again we know from our present knowledge of algebra that  $a^5/a^3 = a^2$  and we can easily prove that this is so by expanding  $a^5$  and  $a^3$  thus:

$$\frac{a^5}{a^3} = \frac{a \times a \times a \times a \times a}{a \times a \times a}$$

Now the three  $a$ 's below will cancel out with three  $a$ 's above to give us  $a \times a$  or  $a^2$ .  $\therefore a^5/a^3 = a^2$ .

In a similar way we can prove that  $a_m/a_n = a_{m-n}$ , where  $m$  is greater than  $n$  and both are positive integral numbers; thus:

$$\frac{a_m}{a_n} = \frac{a \times a \times a \dots m \text{ times}}{a \times a \times a \dots n \text{ times}}$$

Now  $n$   $a$ 's below cancel out with  $n$   $a$ 's above, leaving  $m-n$   $a$ 's above. Hence  $a_m/a_n = a \times a \times a \dots m-n \text{ times}$ .  
 $= a_{m-n}$ .

Thus we see that when we divide one quantity into another of the *same base*, the index of the quotient is obtained by subtracting the indices of the quantities.

### The Law of the Power of a Product

The product  $3 \times 2$  is 6 and  $a \times b$  is  $ab$ . Already we know and can prove that  $(ab)^4 = ab \times ab \times ab \times ab = a^4 b^4$ . Can we prove that  $(ab)_n = a_n b_n$ ?

Since  $(ab)^3 = ab \times ab \times ab$ , therefore

$$\begin{aligned} (ab)_n &= ab \times ab \times ab \dots n \text{ times.} \\ &= (a \times a \times a \dots n \text{ times}) (b \times b \times b \dots n \text{ times}) \end{aligned}$$

Now  $a \times a \times a \dots$  five times is  $a^5$  and  $a \times a \times a \dots$  10 times is  $a^{10}$ , therefore,  $a \times a \times a \dots$   $n$  times is  $a_n$ . Similarly  $b \times b \times b \dots$   $n$  times is  $b_n$ .

$$\therefore (ab)_n = a_n b_n.$$

From this it follows that  $(abc)^3 = a^3 b^3 c^3$ , and  $(6)_n = (2 \times 3)_n = 2_n \times 3_n$ . Again  $(15)_m = (5 \times 3)_m = 5_m \times 3_m$ .

### The Law of the Power of a Quotient

A quotient is the result obtained when one quantity is divided into another. Thus, when we divide  $b$  into  $a$  we get the quotient  $a/b$ . Hence



we see that all fractions are quotients. We know that  $(a/b)^5$  is equal to  $a/b$  multiplied by itself 5 times. Similarly  $(a/b)_n$  is  $a/b$  multiplied by itself  $n$  times.

$$\begin{aligned}\therefore (a/b)_n &= a/b \times a/b \times a/b \dots n \text{ times.} \\ &\quad \underline{a \times a \times a \dots n \text{ times}} \\ &\quad \underline{b \times b \times b \dots n \text{ times}} \\ &= a_n/b_n.\end{aligned}$$

### The Law of Powers

This law is possibly the least well understood of the laws of indices. As explained above, a power consists of the base and its index. Thus the whole term  $a^3$  is the power. Sometimes students are inclined to refer to the index as the power. In  $(a^3)^5$  there are two powers involved, namely,  $a^3$  and  $(a^3)^5$ . As we are concerned with the index of the result when more than one power is involved, this law is known as the law of powers. In  $(a^3)^5$  the 5 outside the bracket indicates that the quantity in the bracket is to be multiplied by itself 5 times. Thus:

$$\begin{aligned}(a^3)^5 &= a^3 \times a^3 \times a^3 \times a^3 \times a^3. \\ &= a^{3+3+3+3+3} = a^{15}.\end{aligned}$$

We see that the index 15 of the result could have been obtained by multiplying the indices 3 and 5. To establish this law, then, we must prove that

$$\begin{aligned}(a_m)_n &= a_{mn}. \\ (a_m)_n &= a_m \times a_m \times a_m \dots n \text{ times.}\end{aligned}$$

But each  $a_m$  is equal to  $a \times a \times a \dots m$  times.

$\therefore (a_m)_n = (a \times a \times a \dots m \text{ times}) (a \times a \times a \dots m \text{ times})$  the bracket being repeated  $n$  times.

Hence there will be  $n$  brackets, each containing  $m$   $a$ 's multiplied together. Hence the number of  $a$ 's multiplied together in the  $n$  brackets is  $mn$ .  $\therefore (a_m)_n = a \times a \times a \dots mn \text{ times.}$

Now " $a$ " multiplied by itself 3 times is  $a^3$  and  $a$  multiplied by itself 8 times is  $a^8$ ; therefore,  $a$  multiplied by itself  $mn$  times is  $a_{mn}$ .

$$\therefore (a_m)_n = a_{mn}.$$

Thus, if a quantity is raised to an index and that power raised to another index, the result is equal to the original quantity raised to an index which is the product of the two original indices.

$$\text{Also } ((a^3)^5)^4 = a^{60} \text{ and } ((ab)_c)_d = a_{bcd}.$$

Now you must *apply* the five laws discussed above. This application can be made in doing the questions on pages 296 and 297 of the text. In doing the questions, make certain that you know in each case what law you are applying. Thus:

$$\frac{(ab)^5}{(a^2b^2)^3} = \frac{a^5b^5}{a^6b^6} = \frac{1}{a^{6-5} \times b^{6-5}} = \frac{1}{ab}$$

Here we applied the law of the power of a product, the law of powers, and the law of division.

In doing questions on indices it is well for the student to note that certain quantities can be reduced to the same base, or expressed in terms of the same power. This is important for the laws of indices apply only

when the quantities with which we deal have the same base. Such numbers as 2, 4, 8, 16, 32, 64, can all be expressed as powers of 2. The numbers 3, 9, 27, 81, 243, can be expressed as powers of 3, and the numbers 5, 25, 125, as powers of 5. For example:

**Example 1.**—Simplify  $27_n \times 9^{2_n} \times 25^{3_n}$

$$\frac{27_n \times 9^{2_n} \times 25^{3_n}}{37_n \times 125^{2_n}}$$

Here we note that the quantities are to different bases. However, we also note that 27 and 9 can be expressed as powers of 3, and 25 and 125 as powers of 5. Hence the above can be written:

$$\begin{aligned} & \frac{(3^3)_n \times (3^2)^{2_n} \times (5^2)^{3_n}}{37_n \times (5^3)^{2_n}} \\ &= \frac{3^3_n \times 3^{4_n} \times 5^{6_n}}{37_n \times 5^{6_n}} \\ &= \frac{3^3_n \times 5^{6_n}}{37_n \times 5^{6_n}} = 1 \end{aligned}$$

In addition to the five laws of indices discussed above, there are three other laws from which we arrive at meanings for quantities with fractional, zero, and negative indices.

### The Law of Fractional Indices

$a^3$  means " $a$ " multiplied by itself 3 times. What does  $a^{1/2}$  mean? Obviously, it cannot mean  $a$  multiplied by itself one-half times. However, from the law of multiplication we know that

$$a^{1/2} \times a^{1/2} = a^{1/2+1/2} = a^1 \text{ or } a$$

That is,  $a^{1/2} \times a^{1/2} = a$ . Now the square root of  $a^{1/2} \times a^{1/2}$  is  $a^{1/2}$ , just as the square root of  $3 \times 3$  is 3. Also the square root of " $a$ " may be expressed as  $\sqrt{a}$ .

$$\therefore a^{1/2} = \sqrt{a}.$$

Similarly  $a^{1/3} \times a^{1/3} \times a^{1/3} = a^{1/3+1/3+1/3} = a$ .

$\therefore$  by taking the cube root of both sides we get

$$a^{1/3} = \sqrt[3]{a}$$

Similarly  $a^{1/4} = \sqrt[4]{a}$ ; and  $a^{1/5} = \sqrt[5]{a}$ . What does  $a^{3/4}$  mean?

$$a^{3/4} = (a^3)^{1/4}.$$

We can see that this is so by applying the law of powers to  $(a^3)^{1/4}$ . Now, since  $m^{1/4} = \sqrt[4]{m}$ , therefore,  $(a^3)^{1/4} = \sqrt[4]{a^3}$ .

It may also be expressed in the following way:

$a^{3/4} = (a^{1/4})^3$ . That this is so may, again, be shown by using the law of powers.

$$\therefore a^{3/4} = (\sqrt[4]{a})^3. \text{ Similarly } x^{5/3} = (\sqrt[3]{x})^5 \text{ or } \sqrt[3]{x^5}.$$

When the base is a number we usually use the first form. When the base is a letter we usually use the second form. Thus:  $8^{5/3} = (\sqrt[3]{8})^5 = 2^5 = 32$ , and  $m^{3/4} = \sqrt[4]{m^3}$ . Note that in changing a quantity with a fractional

index to the surd form we let the denominator of the fraction indicate the root that is to be taken, and the numerator, the power to which that root must be raised.

### The Law of a Zero Index

What does  $a_0$  mean? Using the law of multiplication  $a_0 \times a_m = a_0 + m = a_m$ . That is,  $a_0 \times a_m = a_m$

Divide through by  $a_m$ ,

$$\therefore a_0 = 1.$$

From this it follows that since "a" can stand for any number except zero we can now say that any quantity except zero raised to a zero index is 1. Thus:

$$(-27a)_0 = 1, (-3)_0 = 1, (-37m^3/a^2)_0 = 1.$$

### The Law of Negative Indices

What does  $a^{-3}$  mean? By the law of multiplication  $a^{-3} \times a^3 = a^{-3+3} = a_0 = 1$ . That is,  $a^{-3} \times a^3 = 1$ .

Divide through by  $a^3$ .

$$\therefore a^{-3} = 1/a^3 \text{ from this it follows that } a^3 = 1/a^{-3}.$$

Hence we can now say that a *factor* can be changed from the numerator to the denominator of a fraction and *vice versa* by changing the sign of its index.

$$\text{Thus } \frac{a^{-3} \times a^{-5}}{a^{-4}} \text{ expressed with positive indices is } \frac{a^4}{a^3 \times a^5}$$

Note that the quantities with which you deal must be *factors*.

$$\frac{a^{-2} + a^{-3}}{a^{-4}} \text{ is not equal to } \frac{a^4}{a^2 + a^3} \text{ because } a^{-2} \text{ and } a^{-3} \text{ are not factors but terms.}$$

**Example 2.**—Simplify  $2^{-1}$

$$\frac{2^{-2} - 2^{-3}}{2^{-1} \quad 2^2 - 2^3}$$

A common error here is to regard  $2^{-2} - 2^{-3}$  as factors and say,

$$\frac{2^{-1}}{2^{-2} - 2^{-3}} = \frac{2^2 - 2^3}{2} \text{ which is incorrect.}$$

When you are dealing with terms you must apply the necessary law to the individual term. Thus we know that  $2^{-1} = 1/2$  and  $2^{-2} = 1/2^2 = 1/4$  and  $2^{-3} = 1/2^3 = 1/8$ .

$$\therefore \frac{2^{-1}}{2^{-2} - 2^{-3}} = \frac{1/2}{1/4 - 1/8} = \frac{1/2}{1/8} = 4.$$

**Example 3.**—Solve  $x^{5/3} = 32$ .

If we raise both sides to the index  $3/5$  we get

$$(x^{5/3})^{3/5} = 32^{3/5}.$$

$$\therefore x = (\sqrt[5]{32})^3 = 2^3 = 8.$$

Now do the remaining questions in the chapter on indices.

# Grade XI Physics

## LIGHT—CURVED MIRRORS

1.—**Curved Mirrors.** The curved mirrors used in the study of optics in physics are generally portions of a spherical glass or metal surface. If the outer surface is used as the reflecting surface the mirror is known as *convex*, and if the inner surface forms the mirror it is known as *concave*. In both cases the centre of the sphere of which the curved mirror is a part is known as the *centre of curvature*. The straight line joining the centre of curvature with the centre of the mirror surface is known as the *principal axis*. Any other straight line from the centre of curvature to the surface of the mirror is known as a *secondary axis*. Fig. 1 shows the manner in which the above names are applied to the mirror.

When a beam consisting of parallel rays of light is allowed to strike the surface of a concave mirror the rays are reflected in such manner that they all pass through or very close to a point on the principal axis, as shown in Fig. 2. This point is known as the *principal focus*, "F". It may be defined as that point through which all rays of light near and parallel to the principal axis pass after reflection. The distance from the principal focus to the centre of the mirror is known as the *focal length*, "f". It is found that the principal focus lies half way between the centre of curvature and the surface of the mirror.

When a similar beam of parallel rays fall on the surface of a convex mirror they are reflected in a diverging manner, as shown in Fig. 3. The point behind the mirror from which these diverging rays appear to come is known as the *principal focus*. Because the rays only appear to come from this point, but do not actually pass through it, such a focus is known as *virtual*.

In obeying the elementary laws of reflection of light, all the rays of light striking the surface of a spherical mirror are not reflected so as to pass exactly through the principal focus. This failure of the rays to converge accurately to the principal focus is known as *spherical aberration*. Because of spherical aberration curved mirrors used for practical purposes are generally sections of parabolas instead of sections of spheres and are called *parabolic mirrors*.

2.—**Images Formed by Concave Mirrors.** In order to understand the way in which images are formed in concave mirrors the student should be supplied with a concave mirror, a lighted candle, and a sheet of paper on which to receive the images. The mirror should be set up, in a dark room, at a considerable distance from the candle. The paper should then be moved about near the principal focus to find the image. As soon as the image is located a diagram as shown in Fig. 4 should be constructed.

To locate the image by means of a diagram it is necessary to draw: (1) ray from the tip of the flame parallel to the principal axis which is reflected back so as to pass through the principal focus, and (2) the ray which passes to the surface of the mirror through the centre of

curvature. This ray is reflected directly back on itself as it strikes the surface of the mirror at right angles. The point at which the two rays so drawn cut each other is the point at which an image of the tip of the candle flame is formed. The base of the image of the candle will be on the principal axis immediately above the image of the tip.

The image so formed may be described as being between the centre of curvature and the principal focus, smaller than the object, inverted and real.

The candle should now be moved up to the centre of curvature of the mirror and the image again located by means of the paper screen. A diagram of this case should be drawn as shown in Fig. 5. The rays to be drawn in this case are: (1) that from the tip of the candle reflected back through the principal focus and, (2) that from the tip of the candle through the principal focus which is reflected back parallel to the principal axis. The point where the two reflected rays intersect fixes the position of the tip of the image of the candle flame. The base of the image will be immediately above it. This image may be described as being: located at the centre of curvature, same size as object, inverted, and real.

The candle may now be moved to a position between the centre of curvature and the principal focus. The image will be received on a screen placed at a distance from the mirror. The diagram of this case will be as shown in Fig. 6. The same rays are drawn as in the previous diagram. The image should be located at a distance from the mirror. The image in this case may be described as being: located beyond the centre of curvature, larger than the object, inverted, and real.

If the candle is now moved up to the principal focus rays of light reflected from the mirror will be sent out parallel to each other, and no image will be formed.

For the last case the candle should be moved up until it is between the principal focus and the lens. It is now found that there is no real image formed, that is, no image which it is possible to locate on a screen, but on looking into the mirror an image of the candle is seen behind the mirror. The position of such an image may be located by moving about a needle. When the needle is so located that moving the head from one side of the principal axis to the other while observing both the image and the needle causes no difference in the relative position of these, the image is located as far behind the mirror as is the needle. This method of locating an image is known as the method of parallax. It is a very useful method of locating virtual images, and should be practiced by the student. After locating the image a diagram as shown in Fig. 7 should be constructed. The rays to be drawn in this case are: (1) that parallel to the principal axis reflected through the focus, and (2) that along a secondary axis reflected back on itself. It will be found that these rays can meet only if produced behind the surface of the mirror. In this case the image may be described as being: behind the mirror, larger than the object, erect, and virtual.

After having observed all of the above cases, constructed each of the diagrams, and having satisfied himself in every way that the diagrams constructed express the observed facts, the student should prepare a table as follows:



Position of Object	Position of Image	Size of Image	Image erect or inverted	Image real or virtual
Beyond C of C	Between C of C and F.	Smaller than object	inverted	real
At C of C	At C of C	Same size as object	inverted	real
Between C of C and F	Beyond C of C	Larger than object	inverted	real
At F	No image	formed	rays	parallel
Inside F	Behind mirror	Larger than object	erect	virtual

**3.—Images Formed by Convex Mirrors.** The student should proceed in the case of a convex mirror with the same series of experiments as in the case of the concave mirror. That is, a lighted candle should be brought from a distance in toward the mirror and the image located for each case. All the images formed with a convex mirror will be found to be behind the mirror, smaller than the object, erect, and virtual. Fig. 8 shows a diagram of the rays necessary to draw in order to locate the image.

**4.—Size of Image Formed.** In the case of the image formed in a concave mirror illustrated by Fig. 4, observe the ray AO reflected from the surface of the mirror as OA<sup>1</sup>. By the law of reflection the angle of incidence is equal to the angle of reflection, that is, the angle AOB is equal to the angle A<sup>1</sup>OB<sup>1</sup>. Therefore, the right triangles AOB and A<sup>1</sup>OB<sup>1</sup> have their sides proportional. Thus:

$$\frac{A^1B^1}{AB} = \frac{B^1O}{BO} = \frac{Di}{Do}$$

The size of the image A<sup>1</sup>B<sup>1</sup> is to the size of the object AB as the distance of the image from the mirror Di is to the distance of the object from the mirror Do.

**5.—Conjugate Foci.** On examining Fig. 4 and Fig. 6 it will be seen that when the object is in the position AB the image lies in the position A<sup>1</sup>B<sup>1</sup> illustrated in Fig 4 when the object is at a distance from the concave mirror. In the case of Fig. 6 where the object is between the centre of curvature and the principal focus, the relative positions of the object and image are reversed. It is thus seen that an object placed at AB, Fig. 4, will form an image at A<sup>1</sup>B<sup>1</sup>, whereas if the object is placed at A<sup>1</sup>B<sup>1</sup> the image will be formed at AB. Two points so situated that light from one is concentrated at the other are called *conjugate foci*.

**6.—The Mirror Formula.** Measurements made on Figs. 4 to 8 above or further experiments will prove that the following relation between object distance, Do, image distance, Di, and focal length, f, holds true.

$$\frac{1}{Do} + \frac{1}{Di} = \frac{1}{f}$$

This equation is useful in calculating problems which may arise

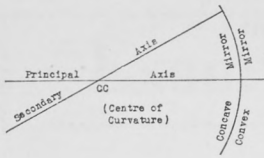


Fig. 1  
Formation of Concave and  
Convex Mirrors.

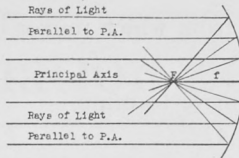


Fig. 2  
Reflection of Light Rays by  
a Concave Mirror.

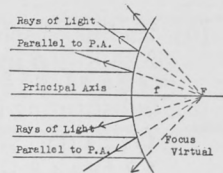


Fig. 3  
Reflection of Light Rays by  
a Convex Mirror

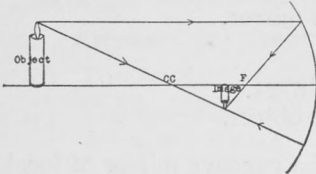


Fig. 4  
Image formed by a Concave  
Mirror when Object is be-  
yond the Centre of Curva-  
ture.

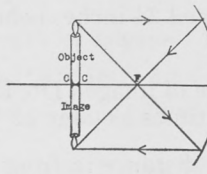


Fig. 5  
Image formed by a Concave  
Mirror when Object is at the  
Centre of Curvature.

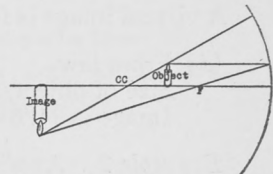


Fig. 6  
Image formed by a Concave  
Mirror when Object is be-  
tween the Centre of Curva-  
ture and the Principal Focus

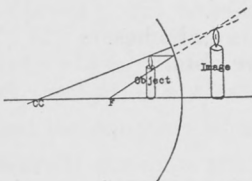


Fig. 7  
Image formed by a Concave  
Mirror when Object is be-  
tween Principal Focus and  
Mirror.

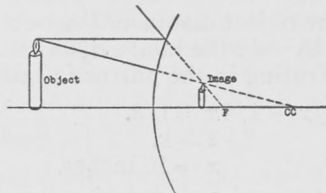


Fig. 8  
Image formed by a Convex  
Mirror.

with the use of curved mirrors, as any two of the quantities may be measured and the other one calculated. The equation is *true* for both concave and convex mirrors. The object distance,  $D_o$ , is always positive; the image distance,  $D_i$ , is *positive* for real images and *negative* for virtual images. The focal length,  $f$ , is taken as positive for concave mirrors which have a real focus, and negative for convex mirrors which have a virtual focus.

**7.—Using the Mirror Formula.** *Example 1.* A candle, 12 inches from a concave mirror, forms a real image 8 inches from the mirror.

- What is the focal length of the lens?
- What is the radius of the sphere from which the mirror is cut?
- Where and what kind of image is formed if the candle is moved to a point 6 inches from the mirror?
- What is the relative size of object and image in the latter case?

*Solution:*

- Mirror formula  $1/D_o + 1/D_i = 1/f$ .

Substituting,  $1/12 + 1/8 = 1/f$ .

Solving,  $2f + 3f = 24$ .

$$5f = 24.$$

$$f = 4.8 \text{ inches.}$$

Focal length of mirror is 4.8 inches.

(b) Radius of sphere from which mirror is cut  
 $2 \times 4.8 = 9.6$  inches.

(c) Substituting in mirror formula,

$$1/4 + 1/D_i = 1/4.8.$$

$$1.2 D_i + 4.8 = D_i.$$

$$1.2 D_i - D_i = -4.8.$$

$$.2 D_i = -4.8.$$

$$D_i = -24.$$

A virtual image is formed 24 inches behind mirror.

(d) From law

$$\text{Size of object/Size of image} = D_o/D_i = 6/24.$$

Image is  $24/6 = 4$  times as large as the object.

*Example 2.* At what distance in front of a concave mirror of focal length 8 inches must an object be placed in order that the image shall be four times as large as the object.

*Solution:*

Let the object distance,  $D_o$ , be  $x$  inches.

Then by rule the image distance  $D_i$  is  $4x$  inches.

Substituting in the mirror formula we obtain

$$1/x + 1/4x = 1/8.$$

$$8 + 2 = x.$$

$$x = 10 \text{ inches.}$$

Object must be placed 10 inches from the mirror.

**8.—Use of Curved Mirrors.** Concave parabolic mirrors are used in searchlights and auto headlights in order to direct the light forward in a straight beam, the light being placed at the principal focus. Parabolic concave mirrors are also used in large reflecting telescopes to reflect to the focus the faint light received from distant stars in order that they may be observed and photographed. Convex mirrors are often used in rear view mirrors for autos. The advantage in using such mirrors is that the image formed is erect and smaller than the object. Thus a considerable part of the road behind the car may be observed in a small mirror.

## 9.—Test.

1. Define each of the following: spherical mirror; parabolic mirror; centre of curvature; principal focus; focal length; principal axis; secondary axis; real image; virtual image; conjugate foci.

2. (a) Using a concave mirror of radius of curvature 8 inches, draw scale diagrams to show the formation of images when the object is placed at 20, 9, 6, 4, and 3 inches respectively from the mirror.

(b) Determine from the scale the image distance and image size in each case.

(c) Apply the mirror formula to each case, calculating the image distance and the image size.

# Examination Solutions

## GRADE X ALGEBRA, 1935 (Sask.)

1. The side of a cube is  $(2m+n)$  inches. Find (a) the total length of the edges, (b) the total surface area, and (c) the volume. Check the results when  $m=2$ ,  $n=1$ .

**Answer:** (a) Total length of edges  $= 12(2m+n) = 24m+12n$ .

(b) Total surface  $= 6(2m+n)^2 = 6(4m^2+4mn+n^2) = 24m^2+24mn+6n^2$ .

(c) Volume  $= (2m+n)^3 = 8m^3+12m^2n+6mn^2+n^3$ .

When  $m=2$ ,  $n=1$ ,

(a)  $= 48+12=60$ , (b)  $= 96+48+6=150$ , (c)  $= 64+48+12+1=125$ .

2. Factor completely: (a)  $a^3 - a$ , (b)  $15x^2 - 32x + 9$ , (c)  $a^2 + 2ab + b^2 - ac - bc$ , (d)  $x^4 + y^4 - 18x^2y^2$ , (e)  $x^6 - y^6$ .

**Answer:** (a)  $a^3 - a = a(a^2 - 1) = a(a+1)(a-1)$ , (b)  $15x^2 - 32x + 9 = (5x-9)(3x-1)$ , (c)  $a^2 + 2ab + b^2 - ac - bc = (a+b)^2 - c(a+b) = (a+b)(a+b-c)$ , (d)  $x^4 + y^4 - 18x^2y^2 = (x^4 - 2x^2y^2 + y^4) - 16x^2y^2 = (x^2 - y^2)^2 - (4xy)^2 = (x^2 - y^2 + 4xy)(x^2 - y^2 - 4xy)$ , (e)  $x^6 - y^6 = (x^3 + y^3)(x^3 - y^3) = (x+y)(x^2 - xy + y^2)(x-y)(x^2 + xy + y^2)$ .

3. Find the equation whose roots are 2 and 3.

**Answer:** If the roots are 2 and 3 then  $(x-2)(x-3)=0$ .

$\therefore x^2 - 5x + 6 = 0$  is the required equation.

4. (a) Simplify:  $\frac{4}{a+4} + \frac{4}{a-4} - \frac{8a}{a^2-16}$ , (b) Divide the product

of  $x^2+3x+2$  and  $x^4-1$  by the product of  $x^2+2x+1$  and  $x^2+x-2$ .

**Answer:** (a)  $\frac{4a-16+4a+16-8a}{(a+4)(a-4)} = \frac{0}{a^2-16} = 0$ ,

(b)  $\frac{(x^3+3x+2)(x^4-1)}{(x^2+2x+1)(x^2+x-2)} = \frac{(x+2)(x+1)(x^2+1)(x+1)(x-1)}{(x+1)(x+1)(x+2)(x-1)} = x^2+1$ .

5. Solve: (a)  $5(x-2)=3.65$ , (b)  $x(3x-1)=10$ ,

(c)  $2x+3y-4z=12$  (d)  $\frac{3}{x} - \frac{8}{y} + \frac{4}{x} - \frac{2}{y} = 11$ ,  $-\frac{4}{x} + \frac{2}{y} = 21$ .  
 $3x-y+2z=15$   
 $4x+y-3z=19$

**Answer:**

(a)  $5(x-2)=3.65$

$\therefore 5x-10=3.65$

$\therefore 5x=13.65$ ,  $\therefore x=2.73$

(b)  $x(3x-1)=10$

$\therefore 3x^2-x-10=0$

$(3x+5)(x-2)=0$

$\therefore 3x+5=0$ ,  $\therefore 3x=-5$ ,

$\therefore x=-5/3$ .

Also  $x-2=0$ ,  $\therefore x=2$

$$\begin{array}{ll}
 (c) \quad 2x + 3y - 4z = 12 \quad (1) & \text{Eliminate } z \text{ from (5) and (6)} \\
 3x - y + 2z = 15 \quad (2) & 11x + 2z = 57 \quad (5) \\
 4x + y - 3z = 19 \quad (3) & 14x - 2z = 68 \quad (7) \\
 \text{Eliminate } y \text{ from (1) and (2)} & \therefore 25x = 125 \\
 2x + 3y - 4z = 12 \quad (1) & x = 5 \\
 9x - 3y + 6z = 45 \quad (4) & \text{Sub. in (5) } 55 + 2z = 57 \\
 \text{Adding, } 11x + 2z = 57 \quad (5) & 2z = 2 \\
 \text{Eliminate } y \text{ from (2) and (3)} & z = 1 \\
 \text{Adding, } 7x - z = 34 \quad (6) & \text{Sub. in (1) } 10 + 3y - 4 = 12 \\
 & 3y = 6 \\
 & y = 2
 \end{array}$$

$$\begin{array}{ll}
 (d) \quad 3/x - 8/y = 11 \quad (1) & \text{Sub. (1) } \quad \begin{array}{r} 3 \quad 8 \\ - \quad - \end{array} = 11 \\
 4/x + 2/y = 21 \quad (2) & \quad \quad \quad \begin{array}{r} 1/5 \quad y \\ - \quad - \end{array} \\
 \text{Eliminate } y & -8/y = 11 - 15 \\
 3/x - 8/y = 11 & \therefore -8/y = -4 \\
 16/x + 8/y = 84 & \\
 19/x = 95 & \therefore y = 2 \\
 \therefore 95x = 19, x = 1/5 &
 \end{array}$$

6. (a) If 8 kilometres equal 5 miles, construct a graph which will enable you to change into miles any number of kilometres up to 20. Read the approximate number of miles in 5, 13, 16, 19 kilometres.

(b) Solve graphically:  $x + y = 5$   
 $2x + 3y = 12$

**Answer:**

(a) See Fig. 5.

$$\begin{array}{ll}
 5 \text{ Km.} = 3\frac{1}{4} \text{ mi. (approx.)} \\
 13 \text{ Km.} = 8\frac{1}{4} \text{ mi. (approx.)} \\
 16 \text{ Km.} = 10 \text{ mi.} \\
 19 \text{ Km.} = 12 \text{ mi. (approx.)}
 \end{array}$$

(b) See Fig. 5.

$$x + y = 5, \therefore y = 5 - x$$

$$\begin{array}{rrrr}
 x & 3 & 2 & 4 \\
 y & 2 & 3 & 1
 \end{array}$$

$$2x + 3y = 12, \therefore y = (12 - 2x)/3$$

$$\begin{array}{rrrr}
 x & 3 & 0 & 6 \\
 y & 2 & 4 & 0 \\
 x = 3, & y = 2
 \end{array}$$

7. The depth of a swimming pool at one end is twice as great as at the other. Eighteen inches of water is drawn off, and the deep end is then three times as deep as the shallow end. What were the original depths?

**Answer:** Let depth of shallow end be  $x$  inches.

Then depth of deep end is  $2x$  inches.

$$3(x - 18) = 2x - 18$$

$$\therefore 3x - 54 = 2x - 18$$

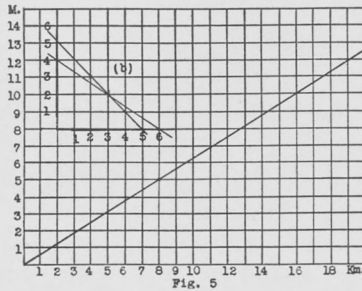
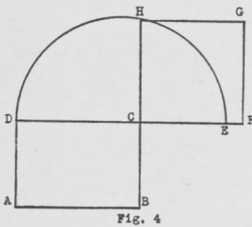
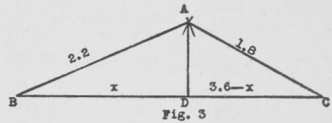
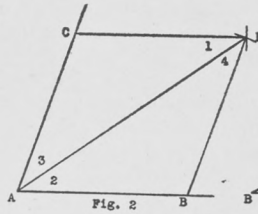
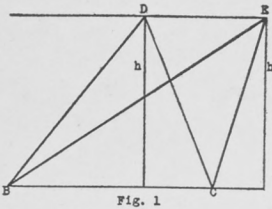
$$x = 36$$

$\therefore$  depth of shallow end is 36 and of deep end is 72 in.

8. A bill for \$7.65 was paid in twenty-five-cent pieces and ten-cent pieces. If there were twice the number of the latter as of the former, how many of each were required?



**Answer:** Let number of 25-cent pieces be  $x$ .  
 Then number of 10-cent pieces is  $2x$ .  
 $25x + 20x = 765$   
 $\therefore 45x = 765$   
 $x = 17$   
 $\therefore$  number of 25-cent pieces is 17, and of 10-cent pieces is 34.



### GRADE X GEOMETRY, 1935 (Sask.)

1. (a) Draw a line BC 3 inches long; at a distance of 2 inches draw a line XY parallel to BC. On the line XY select two points D and E in such a way that a perpendicular from D cuts BC and one from E cuts BC produced. Calculate the areas of the triangles DBC and EBC.

(b) Prove that any two triangles on the same base and of the same altitude are equal in area.

**Answer:** (a) See Figure 1. Area of triangle DBC or EBC =  
 $\frac{1}{2} BC \times h = \frac{1}{2} \times 3 \times 2 = 3$  sq. in.

(b) See Theorem 21, page 128 text.

2. Draw an angle of  $70^\circ$ . Bisect this angle by a geometrical construction. Take any point on the bisector and through that point draw lines parallel to each arm of the angle. Measure the sides of the quadrilateral you have formed. Give a theoretical proof that the figure is a rhombus.

**Answer:** See Figure 2. Required to prove that ABDC is a rhombus.

*Proof:* Since CD is parallel to AB, Construction.  
 $\therefore \angle 1 = \angle 2$  Theorem 10.  
 But  $\angle 3 = \angle 2$  Construction.  
 $\therefore \angle 1 = \angle 3$   
 $\therefore AC = CD$   
 Similarly,  $AB = BD$ .

In triangles ACD, ABD,

$$\angle 1 = \angle 2$$

Theorem 10.

$$\angle 3 = \angle 4$$

Theorem 10.

and AD is common

$\therefore$  triangles are congruent

Theorem 13.

$\therefore AC = BD$  and  $CD = AB$

$\therefore AB = BD = DC = CA$

Since  $\angle A = 70^\circ$ , therefore, none of the angles of ABCD is a right angle.

$\therefore$  ABDC is a rhombus.

3. Prove that if the square described on one side of a triangle is equal to the sum of the squares on the other two sides, then the angle contained by these two sides is a right angle.

**Answer:** See Theorem 25, page 138, text.

4. (a) Prove that the three angles of a triangle are together equal to two right angles.

(b) If one of the exterior angles at the base of an isosceles triangle measures  $107^\circ$ , what is the size of each interior angle?

**Answer:** (a) See Theorem 12, page 87, text.

(b) Since the exterior angle at the base is  $107^\circ$ , the interior angle at the base is  $73^\circ$ . Hence the sum of the angles at the base is  $146^\circ$ .

$\therefore$  the vertical angle is  $34^\circ$ .

5. The sides of a triangular field are 360 yd., 220 yd., and 180 yd., respectively. Draw a plan (scale 1 in. to 100 yd.) and calculate the length of an altitude and find the area of the field.

**Answer:** See Figure 3.  $AB = 2.2''$ ,  $AC = 1.8''$ , and  $BC = 3.6''$

$$y^2 = 2.2^2 - x^2$$

Theorem 24.

$$y^2 = 1.8^2 - (3.6 - x)^2$$

$$\therefore 2.2^2 - x^2 = 1.8^2 - (3.6 - x)^2$$

$$4.84 - x^2 = 3.24 - (12.96 - 7.2x + x^2)$$

$$4.84 - x^2 = 3.24 - 12.96 + 7.2x - x^2$$

$$\therefore 7.2x = 14.56$$

$$x = 2 \frac{1}{45}$$

$$y^2 = 2.2^2 - x^2 = 4.84 - (91/45)^2$$

$$= 4.84 - 8281/2025$$

$$= 1520/2025 = .750617$$

$$\therefore y = \sqrt{.750617} = .86$$

$$\therefore \text{area of triangle} = \frac{1}{2} \times 3.6 \times .86 = 1.548$$

$$\therefore \text{area of field} = 1.548 \times 10000 = 15480 \text{ sq. yd.}$$

6. Prove that the straight line joining the middle points of two sides of a triangle is parallel to the third side and equal to one-half of it.

**Answer:** See page 108 for figure and construction.

*Proof:* In triangles AZY, YVC,

$$AY = YC$$

Given

$$ZY = YV$$

Construction.

$$\angle AYZ = \angle VYC$$

Theorem 1.

$\therefore$  the triangles are congruent

Theorem 2.

$\therefore AZ = VC$   
 and  $\angle ZAY = \angle YCV$   
 $\therefore AB$  is parallel to  $VC$   
 Since  $AZ = VC$   
 $\therefore ZB = VC$   
 Since  $ZB$  is also parallel to  $VC$   
 $\therefore ZV$  is equal and parallel to  $BC$   
 $\therefore ZY$  is parallel to  $BC$   
 Since  $ZY = \frac{1}{2}ZV$  Construction.  
 $\therefore ZY = \frac{1}{2}BC$

7. By a geometrical construction divide a given straight line into five equal parts. Prove your construction.

**Answer:** See problem 7, page 110, text.

8. A rectangle is 3 inches by 2 inches. Show how to construct a square equal in area to the rectangle.

**Answer:**

See Figure 4. Draw a rectangle  $ABCD$  with  $DC = 3''$  and  $BC = 2''$ .  
 Produce  $DC$  to  $E$ , making  $CB = CE$ .  
 On  $DE$  construct a semi-circle.  
 Produce  $BC$  to cut the semi-circle at  $H$ .  
 On  $HC$  describe a square  $CFGH$   
 Then shall  $CFGH$  be equal to the rectangle  $ABCD$ .  
 For proof see problem 18, page 149, text.

9. Give a geometrical illustration of  $a^2 - b^2 = (a+b)(a-b)$ . Explain your diagram.

**Answer:** See part E, page 143, text.

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# Topics of Interest

## MONGOLIAN-SOVIET UNION AGREEMENT

The Soviet Union and the Outer Mongolian Republic entered into a mutual assistance agreement on March 28. Under the terms of what is virtually a military alliance, Russia's huge army will go to the aid of Mongolia in the event of an invasion of the latter's territory by Japan. The mutual aid pact came about as a result of border clashes between Japanese and Mongolian troops and between Japanese and Soviet troops. At the date the agreement was signed the Japanese were massing reinforcements at the northeastern border of Korea following a clash two days earlier between Soviet and Japanese troops.

## GERMANY CROSSES THE RHINE

On March 7, Adolf Hitler sent his troops into the demilitarized Rhineland in defiance of the Locarno pact and the treaty of Versailles. At the moment his troops were crossing the historic Rhine, Hitler, from the rostrum of the opera house in Berlin, declared:

"In this historic hour, when in western provinces our Reich German troops are moving into their future garrisons of peace, we all unite in two holy confessions.

"First, in a solemn oath to recede before no power and no force in re-establishing the honor of our people, and to succumb honorably to the heaviest privations rather than capitulate before it.

"Second, in a determination now more than ever, to help bring about understanding among peoples of Europe, especially among our western peoples and neighbors."

Thus did Hitler put an end to what he regarded as Germany's humiliation under the Locarno pact and the treaty of Versailles. He indicated, however, his willingness to sign non-aggression pacts and air pacts with his western neighbors, and under these conditions to re-enter the League of Nations.

## Britain Acts as Mediator

In the meantime Great Britain is adopting the role of mediator. The French threat to withdraw from the League unless Britain joined her in compelling the German troops to withdraw from the Rhineland has been averted. Germany has refused a League suggestion that she make a "symbolic" withdrawal of her troops while the negotiations for a settlement are in progress. Despite the defiant attitude of Germany, the French at the moment are in a more conciliatory mood. It may be that they realize that Hitler meant just what he said when he proclaimed on March 7 that Germany would "recede before no power and no force." To make the Locarno pact once again operative would require armed intervention and France is not now prepared to go that far. Hitler's position is strengthened by the fact that 99% of the German electorate endorsed his policy when they went to the polls on March 29.

### Italy and the Rhine Occupation

What is Italy's position as a signatory of the Locarno pact? It will be recalled that until Hitler exploded the bombshell of re-militarizing the Rhineland, the League of Nations had felt that they had Italy in a difficult situation. Il Duce had been given a week in which to make up his mind whether he would make peace with Ethiopia "in the framework of the League and in the spirit of the covenant" or submit to oil sanctions. However, on Germany entering the Rhineland, France called upon Italy as a signatory of the Locarno pact to join her in applying sanctions to treaty-breaking Germany. Thus Mussolini suddenly finds himself in a position where, rather than being threatened with sanctions, he is being implored to join in applying sanctions against another nation. His reply to the French foreign minister is to the effect that he will be glad to join France in preserving a united Locarno front against Germany, even to the extent of applying sanctions, provided the application of sanctions against Italy is dropped.

### Alliances

The nations of the world are making haste to form alliances. It is a case of one nation saying to another: "You help me against my enemy here, and I'll help you against your enemy there." The Mediterranean powers, along with Czecho-Slovakia and Rumania are lining up a defensive alliance with Britain against Italy. Czecho-Slovakia, who also speaks for Rumania and Jugo-Slovakia, both of whom are allied with Turkey and Greece, and who is herself a defensive ally of the U.S.S.R., took the lead in urging France to ratify the Franco-Soviet defensive pact, which was concluded a few weeks ago. Germany is endeavoring to form a counter alliance of herself, Poland, Italy, Austria, Hungary, Bulgaria, Albania, Japan, and the rebellious elements in the British and French possessions and dependencies in Africa and Asia, notably in Egypt and Syria.

In the far East, Outer Mongolia and the Soviet have formed an alliance against Japan. The United States is continuing her efforts to gather all the Americas into a peace pact.

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